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ECONOMIC RESEARCH AID

CONSTRUCTION FOR WATER CONSERVANCY IN COMMUNIST CHINA 1949-58

CIA/RR A.ERA 60-3

April 1960

CENTRAL INTELLIGENCE AGENCY

OFFICE OF RESEARCH AND REPORTS

~~CONFIDENTIAL~~

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FOREWORD

The Communist regime in China is undertaking the construction of water conservancy projects in an all-out effort to solve the centuries-old problem of floods and droughts. The extensive construction program, which ranges in magnitude from control of entire river systems to the construction of numerous small projects, provides conditions favorable for economic growth. This research aid assesses the progress and adequacy of the construction effort to control floods and store water against future use during the formative years of the long-range water conservancy program. The research aid also is intended to serve as a support for further studies on the use of water resources for irrigation, hydroelectric power, and transportation in Communist China.

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CONSTRUCTION FOR WATER CONSERVANCY IN COMMUNIST CHINA* 1949-58

Summary

During the years 1949-58, water conservancy was of major concern to the regime in Communist China. Recurring floods and droughts created difficulties in Chinese agriculture, a matter of grave importance because of a consistently narrow margin between the rate of growth of population and the rate of growth in agricultural production. The Chinese Communists, moreover, have attached extreme importance to the role of agricultural production as a basis for the development of industry.

Primarily through the Ministry of Water Conservancy the state was involved both directly and indirectly in construction projects ranging in magnitude from the ambitious control of entire river systems to small farm irrigation systems. The objectives of the water conservancy program were flood control, extension of irrigation, improvement of navigation, and development of the hydroelectrical potential of the river systems. During the years 1952-58 the state invested a total of nearly 5 billion yuan** in construction for water conservancy projects. Construction projects for multipurpose basin-wide river development were underway on two of the river systems, the Huai and the Yellow (Huang) Rivers,*** and plans for the development of several more river systems were in process. Millions of persons, most of whom were unskilled, were mobilized for the water conservancy program. Although a limited amount of construction equipment was used on large-scale projects, the bulk of the work was done, even on large projects, by concentration of labor using the basket and carrying pole and other primitive tools.

* The estimates and conclusions in this research aid represent the best judgment of this Office as of 1 March 1960.
** Equal to about US $2 billion at the implied rate of exchange of 2.46 yuan to US $1. Because there is no way of determining to what extent the cost of labor for water conservancy construction is included in the yuan investment figure, no realistic ratio for construction work can be made.
*** For a discussion of the magnitude of the task of river control on each of these river systems, see Appendixes B and C.

After 10 years (1949-58), some gains have been made in minimizing floods and drought and in improving navigation. Benefits were derived from the extended irrigation facilities, but to an unknown extent. Although gains were made in flood control during normal years, many of the dams were less than adequate during years of severe floods. Reliance on dikes as the chief control of flood waters continued on the river systems. As a result, at the end of 1958, floods and droughts were still serious in Communist China in spite of the tremendous effort to alleviate them since 1949. For the most part, this condition existed because of such natural factors as terrain, climate, and cultivation patterns that can only be partly controlled over a short period. The attitude of expediency that the regime adopted toward water conservancy tended to reduce the potential level of accomplishment that could have been made during the 9-year period.

I. Introduction

Mainland China has had serious losses of water and soil for more than three centuries, in part as a product of its long period of advanced settlement but also in part as a product of local rather than regional or national control.

A. Water Conservancy Problem in General

Water conservancy is concerned with flood control* and the conservation of water and soil in river basins. The role of construction in water conservancy is one of building structures designed to reduce flooding and erosion, to store water against future use for irrigation, to generate power, and to improve navigation. Until the present century, worldwide emphasis in construction for water conservancy was on flood prevention, with work concentrated on river beds and their immediate valleys. Little attention was given to controlling the source of floods -- that is, controlling runoff in the area of the entire river basin. As the study and practice of basin-wide conservation of rivers developed after 1900, not only was flooding reduced and soil erosion alleviated, but also the costly structures intended for flood control were designed for other uses. This concept of combining flood control with maximum use of water resources, as it

* Although widely used, the term control is a relative term. Flooding is caused by factors that man cannot control or change, such as climate, rainfall, and geology. Only to a limited, but very important, extent can man control natural conditions by his treatment of land.

is universally practiced today, is known as multipurpose basin-wide river development.

The planning, design, and construction of projects for all phases of river development is contingent on the study of several disciplines. Over a period of several decades, hydrological and climatological data must be recorded, while over a shorter period -- but still often requiring several years -- geological and topographical surveys must be made and soil samples collected and analyzed. Not only do these studies require a long period of time, but also substantial amounts of man-hours and funds must be expended before an effective program of projects can be planned.

After adequate preparation, it is imperative to coordinate properly the planning and phasing of work to be carried out on the upper and lower reaches of a drainage basin. The manner in which one resource such as soil is handled, for example, may have a serious impact on another resource such as water supply. Unsystematic construction of irrigation facilities in conjunction with flood control projects may have little or no effect on increasing agricultural production and actually may impair it. On the other hand, measures to control erosion should be well underway in a drainage basin before actual construction is started on major projects such as reservoirs. Otherwise, the reservoirs may become silted rapidly.

The development of a river basin therefore requires a high degree of technical skill. Such development also requires close cooperation between the engineer and the various administrative levels of government responsible for the areas affected. Mistakes in planning, design, or construction may prove costly in the long run -- so costly that the mistakes cannot be rectified and may even cause a natural resource to be lost to use forever.

B. Scope of the Water Conservancy Problem

The problem of water -- either too much of it or too little of it -- has threatened the daily existence of man in China for thousands of years. Varying in the size of the area affected and in the degree of intensity, floods occur in some area of the country every year (see the map, Figure 1*).

* Following p. 4.

The entire area of North and South China* is interlaced with myriad streams and rivers. Among them, three major systems -- the Yellow River; the Yangtze River; the Hsi River -- and two minor systems, the Hai and Huai Rivers, traverse the country from west to east through richly productive and populated areas. Other important river systems to the northeast are the south-flowing Liao River and the north-flowing Sungari River.** Much of the rainfall that falls in North and South China eventually drains to the sea by way of one of these systems, so numerous are their tributaries and so vast is their collective area of drainage. North China is a land of wide areas of deserts, plateaus, and fertile valleys and plains, with rainfall that is limited and uncertain (15 to 24 inches per year) and with precarious agriculture and frequent famine. In contrast to this area of brown dryness, South China is green and luxuriant with a long growing season. But even here, although crop failure is rare, an average annual rainfall of 30 inches to more than 60 inches, concentrated seasonally and combined with intensive cultivation of any area with evidence of soil, leads to frequent flooding of low-lying areas and cultivated river valleys, especially those of the southern tributaries of the Yangtze River and the Pearl (Chu) River area.

Based on old records available for those river systems where the major floods occur, the size of the area of China subject to annual fluvial flooding has been estimated to average more than 28,000 square kilometers (sq km), as follows 1/***:

River System	Average Size of Annual Flooded Area (Sq Km)
Yangtze	19,300
Huai	3,710
Hai (vicinity of Tientsin)	2,330
Yellow	2,318
Pearl (vicinity of Canton)	656
Total	28,314

* The division of North and South China used here is a very general one. The boundary is transitional and lies approximately midway between the Yangtze and Yellow Rivers. The rivers referred to are those within the national boundary and do not include international rivers such as the Heilung Chiang (Amur).

** In the dry interior are rivers similar to the Tarim (T'a-li-mu) River, which loses much of its water by evaporation before it flows into the salt lake of Lop Nor.

*** For serially numbered source references, see Appendix D.

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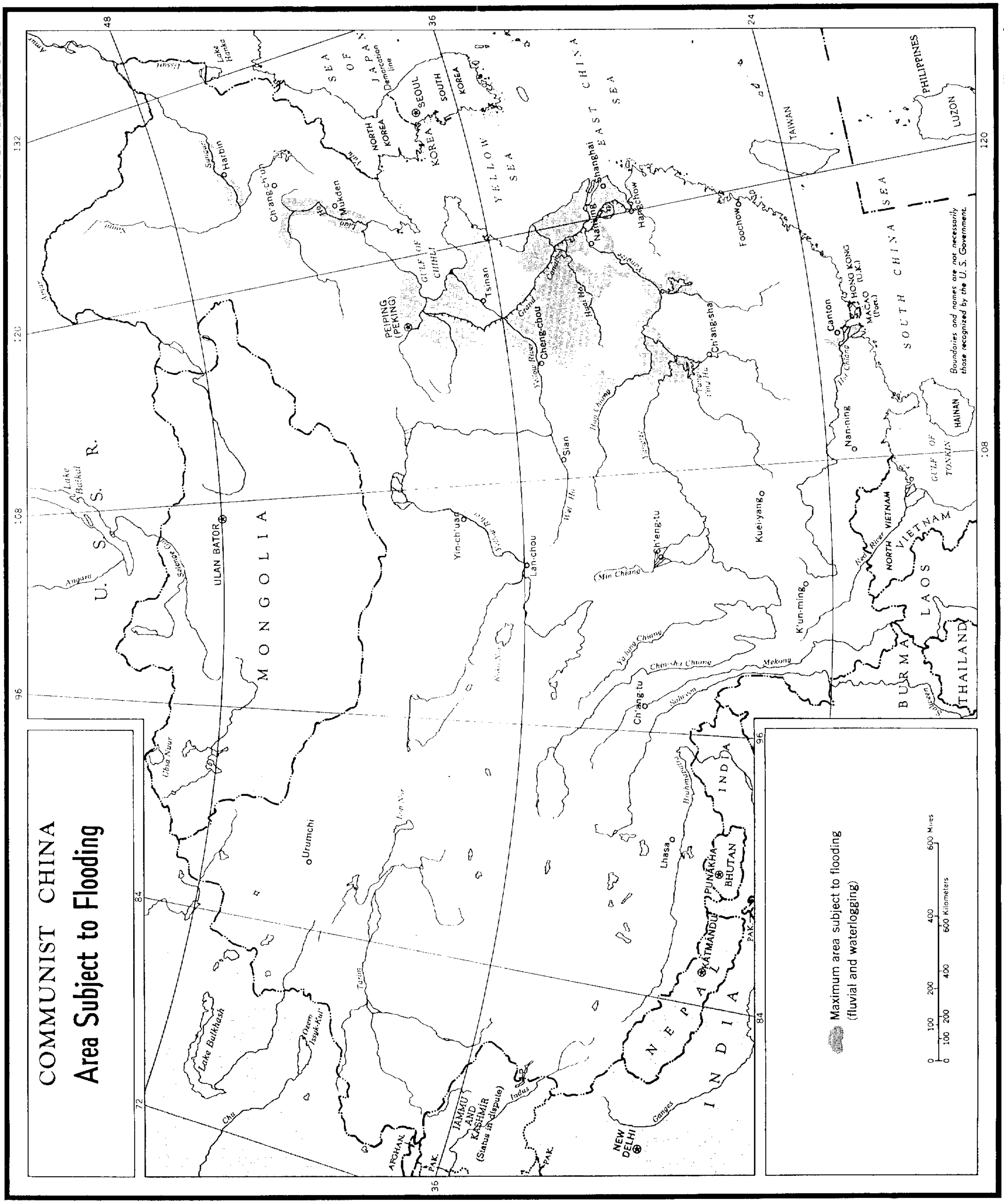

Figure 1

Floods on the Yangtze River occur over a wide area around the lakes near Wu-han and in the area of Lake Tung-t'ing and Lake P'o-yang. These lakes are fed not only by high water in the main stream but also by a large northern tributary, the Han River, and three large southern tributaries, the Yüan, Hsiang, and Kan Rivers. Floods in the Yangtze Delta are not common, but when they do occur, they can be caused from tidal flooding or from a flood peak of the Huai River coinciding with high water on the Yangtze River. The most frequent flood damage has occurred from the Huai River because the volume of flood water, which cannot be drained readily to the sea, is much larger than the storage facilities of the terminal lakes into which it flows. The Hai River is fed by a large number of heavily silted rivers originating from northern Shansi Province, the most important of which is the particularly turbulent Yung-ting River. The floods caused by breaks in the dikes of the Yellow River probably are the most destructive, as they persist for long periods and carry a tremendous load of silt. The entire area of the Yellow River Plain, more than 260,000 sq km, has been flooded at one time or another. The Pearl River Delta area is fed by several rivers, the major one of which is the Hsi River, so that prolonged heavy rainfall causes serious floods in the vicinity of Canton.

Most of the natural vegetation cover in North China, especially in the drainage area of the Yellow River, has been stripped for use as building material, fuel, and food. In areas of steep slope (more than 30 percent) the loss of soil by erosion is very high. The amount of silt washed down the Yellow River is estimated to be nearly 1.4 billion metric tons per year* and that down the Yangtze River about 600 million metric tons annually.** 3/ With such heavy erosion, reservoirs, canals, and river channels rapidly become silted and unusable.***

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* This estimate made by the Communists for the silt flow of the Yellow River is lower than that made in 1947 by US engineers, who estimated it to be 1.89 billion metric tons per year. 2/ It is improbable that the amount of water and soil conservation work done since 1947 could reduce the silt flow 26 percent. The difference more likely is due to the fact that both estimates are based on incomplete data.

** The Mississippi River above the delta yields about 500 million metric tons of sediment per year. 4/

*** The Kuan-t'ing Reservoir on the Hai River system, which was completed in 1954 and has a storage capacity of 2.27 billion cubic meters (cu m), according to estimates made at the end of 1957, had accumulated 175 million cu m of silt. 5/ At this rate the reservoir would become completely silted in a period of 40 years.

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II. Performance in Water Conservancy Construction, 1949-58

A. General

Under the Communist regime, construction for water conservancy projects has been more extensive than any previously undertaken in China (see the map, Figure 2*). Any success of this construction can be attributed to two important factors -- a more centralized administrative control and nationwide mobilization of labor. During 1949-58 the total amount of earth and stone moved, a measure of physical accomplishment in construction for water conservancy projects, was more than 70 billion cu m, 6/ about 80 percent of which was moved in 1958 alone.** In addition to construction carried out on dams and reservoirs during 1949-58, construction of irrigation facilities was claimed to have extended the area under irrigation to a total of 66 million hectares*** by the end of 1958.**** 8/

After the Communists assumed control of the entire country in 1949, work in water conservancy was intensified, with emphasis on local flood prevention, land reclamation, and the rehabilitation and development of irrigation. Included in this work was the repair and strengthening of most of China's estimated 42,000 km of dikes, especially those on the Yangtze, Yellow, and Hai Rivers. Construction also was started on a series of projects aimed at controlling floods on the entire Huai River system.†

In spite of the construction effort expended by 1956, serious flooding persisted as is shown by the size of the area reported to be affected annually by floods:

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* Inside back cover.

** The Chinese Communists consistently reported a total of 58 billion cu m as the amount of earth and stone moved during 1958. Even though this figure probably is overstated, more work was performed in 1958 on large-scale as well as medium-scale and small-scale projects. Also, in that year, probably greater use was made in some areas of earth-moving machines (for example, a lorry operated by a pulley) and of explosives for loosening dirt in excavation on medium-scale and small-scale projects. 7/

*** One hectare equals 2.47 acres.

**** An increase of about 50 million hectares in comparison with an estimate of 15 million to 16 million in 1949.

† For a discussion of the Huai River system, see Appendix B.

Year	Area Affected by Floods* (Sq Km)
1949	67,000**
1950	40,000**
1951	13,000**
1952	10,000**
1953	N.A.
1954	90,000***
1955	N.A.
1956	90,000****

The loss of life, crops, and property from such floods cannot be expressed in monetary terms. As a rough indication of the "cost" of flood damage, however, it is estimated that the state in 1954 and 1956 alone spent an amount equal to about 49 percent of the total capital investment in water conservancy on flood relief and restoration during a 5-year period.†

Although the Chinese Communist press reported from time to time that work in water conservancy had shifted from mere prevention to the control of floods and drought, no real move was made in this direction until 1956. In June of that year it was announced that the number of above-norm projects†† to be completed or started by the end of 1957 in water conservancy was to be increased from 61 to 136. 12/ During 1956, there was increased activity not only in physical accomplishment but in planning. The National Agricultural Development Program, a draft 12-year plan (1956-67) covering water and soil conservation, was promulgated. 13/ It was planned to complete conservation on an area of more than 1 million sq km by 1967. It was claimed that this program would all but eliminate losses from soil erosion.

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* Areas were reported in million hectares: 100 hectares equal 1 sq km.
** 9/
*** 10/
**** Derived from source 11/.
† See methodology, Appendix A.
†† A limit or norm in construction cost has been established in Communist China for both new construction projects and reconstruction projects. The Chinese Communists, however, have not announced the norm for water conservancy projects. The construction cost of large-scale multipurpose reservoirs may range from 50 million yuan to nearly 1 billion yuan.

The program also called for plans for river control, and, in 1957, preliminary plans for basin-wide development were reported as completed for the Yellow,* Huai, Han, and Liao Rivers and 90 other rivers, while similar plans were reported as underway for the Pearl River area, the Yangtze and Sungari Rivers, and 87 other rivers.

In October 1957, there was begun a water conservancy campaign that was never before equaled in China. Millions of peasants were mobilized for the construction of medium-scale and small-scale irrigation projects over a wide area. During 1958, as communes began to be established, they facilitated the mass mobilization of labor to an even greater extent than under the agricultural cooperatives.

Although emphasis in the press was on the medium-scale and small-scale projects underway during 1958, construction started on a greater number of large-scale projects than in any previous year. The National Planning Commission announced in February 1958 that construction would start on 35 new above-norm water conservancy projects during the year. Including the projects carried over from 1957, the state would construct a total of 73 projects, 21 of which would be completed by the end of 1958. 14/

B. Major Inputs in Construction

1. Capital Investment

During 1952-58 a total of nearly 5 billion yuan was invested in water conservancy construction in Communist China. Annual distribution of this investment reported by the Chinese Communist State Statistical Bureau was as follows 15/:

Year	Investment (Million Yuan)
1952	410
1953	480
1954	220
1955	410
1956	710
1957	730
1958	1,960
Total	4,920

* For a discussion of the Yellow River system, see Appendix C.

In 1958, as indicated above, capital investment increased markedly. Whereas total capital investment increased 93 percent above that in 1957 (from 13.8 billion yuan in 1957 to 26.7 billion yuan in 1958), capital investment in water conservancy in 1958 jumped nearly 168 percent above that in 1957. This substantial increase in investment in water conservancy probably can be attributed to the increase in the number of large-scale projects under construction during 1958, a greater number than in any previous year.*

2. Labor Force

The work accomplished in construction for water conservancy in Communist China during 1949-58 in large part was attributable to the widespread use of mass labor. Official announcements of the over-all size of this labor force vary, but the number employed always was reported in terms of millions of persons. Included in this number were a few hundred thousand technicians and skilled workers engaged on large projects, but the vast majority was unskilled labor. Although labor was amassed during the early years, beginning in 1955, the efficiency of state control over this labor force was increased by the establishment of agricultural cooperatives. With the new program in 1957 aimed at greater utilization of the underemployed labor force, an upsurge began in October in work on all phases of water conservancy. As communes began to be established in 1958, great quantities of manpower were applied on a scale never before seen in China. As high as 70 to 90 percent of the total number of able-bodied men and women in some areas were used. 16/

A direct relationship exists between the amount of work performed and the size of the labor force used in construction for water conservancy projects in Communist China. It is estimated that about 98.9 percent of the combined earthmoving, masonry, and concrete work in construction for water conservancy projects is represented by earthmoving.** Large quantities of earth are moved in the construction of reservoirs; in the dredging and excavation of canals, ditches,

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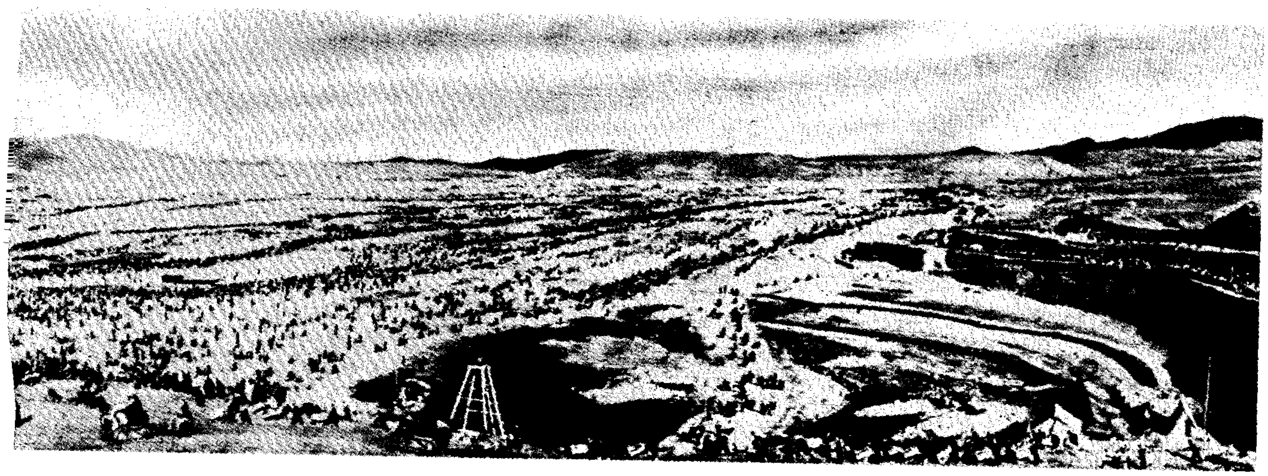
* The increase also may reflect a transfer of a portion of capital investment funds formerly allocated to the Ministry of the Electric Power Industry to the new Ministry of Water Conservancy and Electric Power, when the two ministries were combined early in 1958. This supposition is highly tenuous, however, but is based on the data available.

** It is estimated that of the remaining 1.1 percent, masonry work (including moving the stone and placing it in position) accounts for about 1 percent and concrete work for 0.1 percent. This estimate is an average derived from various reports in which the amounts of each of these types of work were given in cubic meters in relation to one another.

and other irrigation facilities; and in the construction and maintenance of dikes. Because most of the earth and stone is moved by hand in China, the larger the size of the labor force, the greater the amount of work that can be performed. (The above photograph of construction work on one of the reservoirs on the Huai River shows the typical Chinese Communist technique of employing thousands of manual laborers for the massive moving of earth on large construction projects.)

Throughout the period of the First Five Year Plan (1953-57) the Chinese Communists claimed increased efficiency in the amount of earth moved per man per day through the use of improved tools. Even though the use of simple earthmoving mechanisms was adopted in many areas, it is evident that the basket and carrying pole was not completely replaced, for in 1958 the Chinese Communists were still using the old standard norm of 2 cu m of earth per man per day as an average for making estimates for the amount of labor required on water conservancy projects. 17/ If this norm is applied to amounts of earth and stone reported moved during 1949-58, an estimate of the average annual number of man-days worked in water conservancy can be made as follows:



Year	Earth and Stone Moved (Million Cubic Meters) Actual Amount*	Average Annual Amount	Average Number of Man-Days Worked per Year (Million)
1949-52	1,700	600**	300
1953-54	1,200	600	300
1955-57	5,100***	1,700	850
1958	58,000	58,000	29,000****

The greatest portion of the unskilled labor force was composed of peasants. In addition, members of the Peoples Liberation Army; compulsory reform units; and, especially during 1958, students, teachers, and members of the urban population were called to "volunteer" a few weeks or months of their labor. Apparently,

* Data herein presented are from source 18/. The total of these data differs slightly from the reported total of 70 billion cu m.

** Estimated at about 600 million cu m.

*** The amount for 1955-57 was derived by subtracting the figure reported for 1953-54 (1.2 billion cu m) from the total of 6.3 billion cu m reported for the years 1953-57.

**** Based on a construction year of 300 days, about 97 million man-years of labor were contributed.

food was the only compensation that the labor force received. In some instances, not even food was provided, and the "volunteers" were forced to furnish their own food. 19/

C. National Water Conservancy Agencies

1. Ministry of Water Conservancy

Although the administrative details of construction for water conservancy projects in Communist China are obscure, some general observations can be made. The Ministry of Water Conservancy, which was established in 1950 and which functioned independently until 1958,* was responsible for flood control and irrigation. Probably all construction for water conservancy projects was to some degree subject to the supervision of this ministry.

During 1950-57,** construction plans for those water conservancy projects under the direct supervision of the ministry probably included: (a) projects undertaken by agencies directly under the ministry; (b) projects in the Pearl River area and on the Grand Canal and projects on the Yellow, Yangtze, and Huai Rivers; (c) projects affecting more than one province; and (d) projects the construction of which could not be undertaken by a single province. Below the ministry were three successive levels of administration (province, water conservancy districts,*** and counties), each with construction responsibilities for projects falling within their own needs and areas. 22/

The decentralization program that began in 1958 probably shifted some of the responsibility within this structure. It is possible that most of the responsibility for construction projects below

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* In 1958 this ministry was combined with the Ministry of the Electric Power Industry and was renamed the Ministry of Water Conservancy and Electric Power. 20/ The reason for this change has not been announced officially, but the unresolved question of responsibility for capital investment and duplication in designing for river development projects certainly contributed to the basis for combining these two ministries. 21/

** Construction plans of the administrative areas also were directly supervised by the ministry until the administrative areas were abolished in 1954, at which time their responsibility probably was shifted to the ministry.

*** A water conservancy district may encompass more than one administrative area, and its extent is usually determined by the extent of a drainage area or some other determining factor of water supply.

the provincial level was shifted to the communes, with water conservancy districts and counties still retaining some degree of responsibility. Probably the provinces were delegated more responsibility for projects involving work on sections of major rivers or canal systems that lay within their territory.

2. River Commissions

In 1955, there were four river commissions within the Ministry of Water Conservancy, each responsible for an important river project -- the Yellow River Water Conservancy Commission, the Yangtze River Water Conservancy Commission, the Huai River Control Commission, and the Ching Chiang River* Control Commission. Each commission, made up of representatives from the provinces through which the particular river flowed, apparently had its own bureaus for administration, survey, design, construction, supply of materials, equipment, and manpower. At least the first three of these commissions continued to function throughout the First Five Year Plan and during 1958.

Apart from, and apparently above, the Ministry of Water Conservancy was the Yellow River Planning Commission. This agency, jointly organized in 1954 by the Academy of Science and the Ministries of Water Conservancy, Fuels, Industry, Agriculture, Railroads, Communications, and Geology, was responsible for the long-range development plan of the Yellow River. 23/

3. Central Flood Prevention Headquarters

The Central Flood Prevention Headquarters, which began functioning in April 1953, had its main office in Peking. 24/ It was reported in May 1959 to have established headquarters in all the provinces. The agency apparently was responsible for inspection of, and the allocation of materials and equipment for, the maintenance of dikes and other temporary flood control projects. 25/

D. Research and Training

When the Communists came to power in China in 1949, the shortage of qualified engineers necessitated reliance on Soviet engineers for the planning and construction of large water conservancy projects. By the end of 1957, as a result of Soviet training, it was claimed that there were 30,000 technicians in Communist China capable of designing dams, reservoirs, hydroelectric power stations, and large-scale irrigation projects. 26/

* The section of the Yangtze River from Chih-chiang (30°19' N - 111°30' E) downstream to the mount of Lake Tung-t'ing.

The stipulation laid down by the First Five Year Plan for long-range research in water conservancy to be carried out by 1962 necessitated an extensive training and research program. 27/ This program, controlled by the Ministry of Water Conservancy, covered flood control, coordinated river and stream planning, hydraulic engineering, erosion control, forestation, and irrigation. It was reported that, in general, about one-tenth of the total allocation for water conservancy projects was set aside for research. 28/

The main training and research establishment was the Peking Water Conservancy Institute under the direction of the Ministry of Water Conservancy. Its main task was to carry out large-scale experiments and basic research that the ministry was unable to undertake. In addition to all phases of water utilization, the institute engaged in research on concrete, soil structure, irrigation, and alluvium. Under this central institute at Peking were five subsidiary research establishments concerned with special problems.* The budget allocation of these stations was about one-fourth that of the Peking Central Research Institute. 29/ Other schools, also under the control of the Ministry of Water Conservancy, were several water conservancy academies that specialized in hydraulic engineering as it relates to land improvement, canals, and harbors.

Even though the staff of these schools suffered from a shortage of qualified engineers, the teachers were required to contribute several weeks or months to water conservancy projects. Up to a point, the use of these teachers resolved the problem of allocating the limited supply of engineers, whether they were used to train others or were assigned to construction projects.

III. Effectiveness of the Construction Effort

In 1958, in spite of the tremendous effort expended since 1950, the threat of floods and drought was still serious in Communist China. For the most part, this situation existed because of natural conditions, but the regime's handling of the program of construction for water conservancy also contributed to the problem. The Chinese Communists had some advantage over previous regimes in China in construction for water conservancy projects. The Chinese Communists promulgated a more centralized administrative control, showed a greater facility for mobilizing a labor force, and, perhaps most important of all, had a prolonged period of internal peace in which to work. But most of the problems confronting former regimes continued to plague

* For example, the station at Cheng-chou was concerned with the behavior of the Yellow River, especially the problem of silting, whereas the station at Pang-fou conducted research connected with the construction of dams on the Huai River.

the Chinese Communists. They were faced with a shortage of qualified engineers, they were inexperienced in planning, and they lacked necessary research data.

Confronted with these problems and fully aware of the magnitude and long-term nature of the task, the Chinese Communist regime frequently approached the task with an attitude of expediency. In many ways, only lip service was paid to the scientist and engineer until such time as circumstances forced a more conciliatory attitude. Plans were formulated, and construction was started on large projects, without adequate preparation. As a result, several projects had to be rebuilt completely because of faulty design and poor construction and thus required twice the amount of input. Often the construction of medium-scale and small-scale projects was pursued without coordination with, or consideration for, long-range planning. The millions of peasants, who were mobilized over a wide area for these projects, were left more or less to their own devices. 30/ Such indiscriminate construction in the long run could prove to be an actual detriment to agricultural production and to a program of water and soil conservation, could lessen greatly the chances of effecting flood control, and even could create a serious imbalance in water supply.

The problems related to construction for water conservancy projects cannot be overcome in a short period of time. Their solution, however, is vital to implementing an adequate program of water conservancy. The regime needs to take a more cautious and realistic approach to the solution of the problems if it is to achieve any real measure of control over its rivers and the use of its water resources in future years.

APPENDIX A

METHODOLOGY

Estimate of the Cost of Flood Damage

An approximate indication of the cost of flood damage to Communist China may be derived from an examination of state expenditures. During the period of the First Five Year Plan (1953-57), two serious floods occurred, one in 1954 and one in 1956. It was reported that the extent of the area flooded in 1954 was 90,000 sq km* 31/ and that the average extent of the area flooded in both years was 90,000 sq km.** 32/ As a result of the flood in 1954, the state allocated more than 374 million yuan for flood relief and about 244 million yuan for closing breaches, for restoring dikes, and for other flood prevention work, 33/ making a total expenditure of 618 million yuan. Although the flood of 1956 was reported as more destructive than the flood of 1954, the amount spent for flood relief and restoration work in 1956 is assumed to be approximately the same amount as that spent in 1954, based on the estimate by the Chinese Communists of the extent of the area flooded. Thus the total amount spent by the state as the result of these two serious floods was about 1.24 billion yuan.

During 1953-57, capital investment in construction for water conservancy projects was 2.55 billion yuan.*** Thus the state spent on flood relief and restoration as a result of the two serious floods alone during the 5-year period an amount equal to about 49 percent of total capital investment in construction for water construction for water conservancy projects.

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* The area was reported as 9 million hectares.

** The average area affected by flood and drought each year (1954 and 1956) was reported as 12.8 million hectares, with floods accounting for 70 percent of the area, or about 9 million hectares (90,000 sq km).

*** See III, B, 1, p. 8, above.

APPENDIX B

HUAI RIVER SYSTEM

By the end of 1957, seven reservoirs, a large irrigation system, and a hydroelectric power station were reported as completed on the Huai River and its tributaries (see the map, Figure 3*). During 1950-57 it was reported that a total of about 1 billion yuan was invested for construction projects to control the river. 34/ Because it is estimated that approximately 2.96 billion yuan** were invested in construction for water conservancy projects during 1952-57, the Huai River system alone received about one-third of the total state investment during the 6-year period. The allocation of the 1 billion yuan of capital investment*** for the Huai River in terms of the type of project was announced as follows 35/:

Project	Capital Investment (Percent)
Reservoirs	35.0
Drainage	28.1
Flood prevention	23.3
Irrigation	7.7
Other	5.9
Total	100.0

The projects completed on the Huai River during 1950-57 involved 894 million cu m of earth moved, 5.81 million cu m of masonry work, and 1.47 million cu m of concrete work. 36/ About 447 million man-days were required to move the amount of earth alone on these projects. Even with the substantial funds and labor already expended by 1957, a revision of the plan in 1957 called for a considerable amount of work to be carried out during the next 10 years on the control phase of the Huai River.

* Following p. 20.

** For capital investment in construction for water conservancy projects, see III, B, 1, p. 8, above.

*** In addition, about 600 million yuan were spent by the state for sealing breaches, for restoring dikes, for operating expenses, and for relief funds.

The drainage basin of the Huai River lies approximately midway between the lower reaches of the Yellow River and the Yangtze River and covers an area of more than 290,000 sq km. The Huai River, about 1,000 km long, rises in the T'ung-pai Mountains in Honan Province and flows in an easterly direction across Honan and Anhwei Province, where it empties into Lake Hung-tze. Flowing into the reaches above the lake are more than 28 tributary streams that drain most of the area of Honan and Anhwei Provinces. Some of these tributaries are quite large and have many tributaries of their own.

A particular characteristic of the Huai River is frequency of floods caused by recurring rainstorms during the wet season of the year. The heavy rains turn the tributaries into torrents, and because there is a general flatness to the terrain in their lower reaches, rain water as well as flood water and silt collects in the low-lying areas around the confluences of the tributaries and the main stream. Lake Hung-tze acts as a natural detention reservoir for flood waters, but successive deposition of silt has reduced its capacity, so that in periods of serious flooding its shallow depths cannot contain the increased volume of water. Successive invasions by the Yellow River into the area from Lake Hung-tze to the sea deteriorated the lower reaches of the Huai River in Kiangsu Province, leaving the river without a good natural and direct outlet to the sea. Because of the general flatness of the terrain in the lower reaches, waterlogging* also occurs and is fed by flood waters from the rivers in the Shantung-Kiangsu border area. Thus a serious flood on the Huai River can cause widespread destruction to richly productive and heavily populated areas in four provinces and to large sections of the Grand Canal over a distance of some 430 km.

In general, the construction projects for river control, irrigation, and navigation carried out by the Chinese Communists during 1949-58 -- except in the order of activities undertaken -- closely followed projects recommended approximately 20 years earlier by the old Huai River Commission.** 37/ In 1950 a major flood on the Huai River inundated nearly 3 million hectares of farmland. Because floods were more likely to occur on this river than on other rivers,

* Flooding resulting from accumulation of rain water in depressed areas that do not have good natural drainage. Waterlogging can result also from seepage of ground water or seepage through embankments.

** At that time the engineering work was to be phased in two 5-year periods to provide adequate flood escape channels and to improve drainage, irrigation, and navigation. Construction of reservoirs, irrigation and drainage systems, and hydroelectric power projects on the upper reaches of the river and its tributaries was considered also, but many more data were needed before designing could be started.

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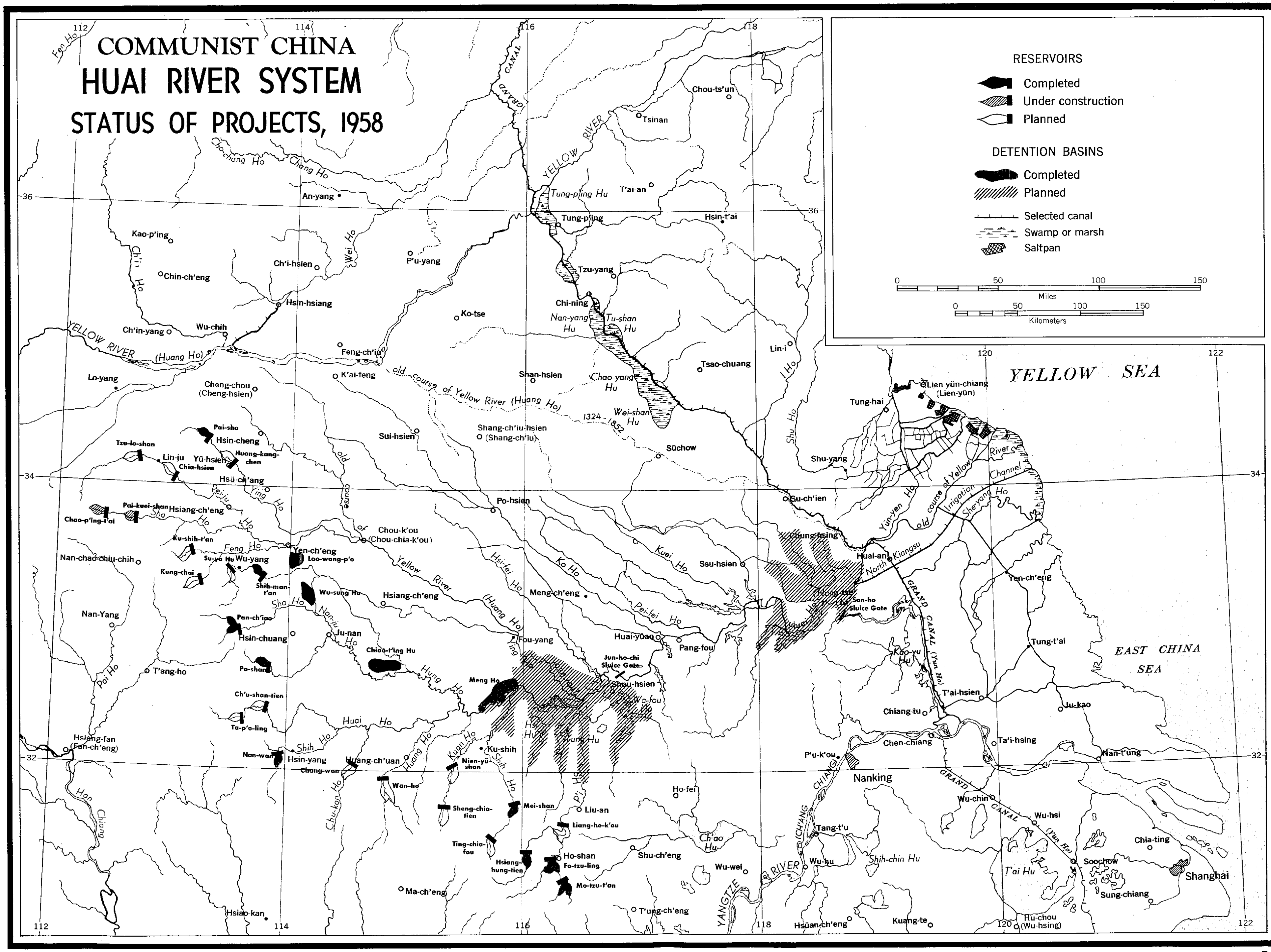

Figure 3

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success in its control would be a distinct advantage to the new regime. Consequently, in October 1950, the State Administrative Council decided to "harness" the Huai River by 1955. Reports vary as to the number of reservoirs originally planned to be constructed in the 5-year period 1950-55, but, after 2 years of effort, the Minister of Water Conservancy announced that 13 reservoirs were to be built -- fewer than any number initially planned. Along with the construction of the reservoirs, 17 detention basins* were scheduled for completion as well as extensive dike construction, dredging, and the cutting of two new channels to separate the waters of the Huai River from Lake Hung-tze. 38/ The repercussions from the initiation of construction for major projects without adequate data and experience in planning and designing were felt acutely when two serious floods occurred in 1954 and 1956. The dams of the Po-shan, Pan-ch'iao, and Pai-sha Reservoirs proved to be too low and had to be raised in the winter of 1956. Because of the poor selection of reservoir sites on the P'i River, construction of a fourth dam, in addition to the Fo-tzu-ling, Hsiang-hung-tien, and Mo-tzu-t'an Dams, was required for satisfactory flood control. Cracks developed in the earth dams at Pan-ch'iao, Pai-sha, and Shih-man-t'an as a result of the poor quality of construction. These dams were almost completely rebuilt, thus doubling the cost of construction. Although plans had been made to provide drainage for waterlogged areas along the Huai Valley, this aspect of river control was neglected. Apparently, part of the funds to be used for the construction of projects related to drainage were used for the construction and reconstruction of reservoirs. Necessary work on channel regulation, which had to be done before construction of these projects, was never carried out. 39/ Even though it was claimed that the threat of flood damage was greatly reduced in the Huai River system by the end of 1957, flooding was still serious. An average of 2 million hectares was flooded annually, and of this total about 1.8 million hectares of flooding were attributable to waterlogging. 40/

In 1957 a revised plan was announced, calling for the construction of a total of 27 reservoirs, an increase of 9 above the greatest number reported as planned.** This new plan was to be carried out in two phases of construction. 41/ During the first phase (1958-62) the construction of reservoirs and detention basins was to be completed, and additional navigation locks were scheduled to be constructed. By the end of the second phase in 1967, 24 large hydroelectric stations at the reservoir sites and 54 small stations along the river were scheduled

* A detention basin is a temporary lake. It is formed by the construction of dikes or similar structures at angles to the stream in order to divert the water into low-lying areas.

** In 1950 the greatest number of reservoirs reported as planned was 18.

to be completed. Extensive construction for drainage and irrigation was to be completed, and it was claimed that eventually more than 6 million hectares would be brought under irrigation in the basin. Dredging and construction of locks by 1967 will make the main stream and some of its main tributaries navigable for powered vessels.

Even with the increase in the number of reservoirs to be constructed, the goals and timing of this plan were more reasonable than the 1950 plan. The rate of reservoir construction, however, will have to be increased more rapidly than the one-a-year rate maintained during 1950-57 if this portion of the plan is to be realized even by 1967.

APPENDIX C

YELLOW RIVER SYSTEM

In 1955 the Second Session of the First National Peoples Congress of Communist China passed a resolution approving a plan for the multipurpose control of the Yellow River and for the exploitation of its water resources. 42/ The entire plan postulated decades for completion. The water and soil conservation program alone is expected to consume at least 50 years. 43/ The major portion of the construction called for in the plan was scheduled to be completed during the first phase, 1957-67 (see the map, Figure 4*). The Chinese Communists initially estimated the total capital investment for the first phase of the program at about 5 billion yuan.** 44/ Since that time, reductions in construction costs for various projects have been reported, but even with reductions in cost this 10-year phase probably will require a substantial investment.

The Yellow River presents a tremendous challenge to the engineer. It is the heaviest silt-laden river in the world, estimated to carry away between 1.4 billion and 1.9 billion tons of silt per year. It is large and torrential and has a high ratio between maximum and minimum discharge. The Yellow River has a short flood duration*** and a comparatively small flood volume and carries away most of its silt during floods. It is the second largest river in China (next to the Yangtze), with a length of more than 4,600 km and a drainage area of more than 770,000 sq km. In its upper stretch, the river flows generally eastward through gorges to the vicinity of Lan-chou, where it turns northward. Along the river and its tributaries, some broad fertile valleys are developed in the stretch above Lan-chou down to the Ningsia Hui Autonomous Region. Beyond the Ningsia Hui Autonomous Region, at Teng-k'ou, the river makes a great arc to the east around the Ordos Plateau. Here the valley broadens, and the river meanders, slowing its velocity and in the process causing its silt load to be deposited in the western corner of the arc. Beyond Pao-t'ou the river slope is flat for about 100 km until it reaches T'o-k'o-t'o, where it turns abruptly south and the steepness of the bed increases rapidly. Even at low water the current flows at a high velocity over

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* Following p. 24.

** The Communists claimed that, through improved irrigation alone, returns on this investment could be realized in less than 10 years by income from increased production of grain and cotton.

*** The flood, in 1942, the highest flow ever recorded, lasted 2 days. 45/

falls and rapids, among them Ho-k'ou Falls and Lung-men Rapids. About 30 km above T'ung-kuan the valley becomes broad and flat, and the velocity of the river is slowed down considerably. This section of the river between T'o-k'o-t'o and T'ung-kuan (about 900 km) receives water from numerous tributaries on both sides, among which are the large Wu-ting and Fen Rivers. These tributaries drain much of the highly erosive loess areas of Shensi and Shansi Provinces, so that the Yellow River collects not only most of its flood flow from this section but also a tremendous silt load.* At T'ung-kuan is the confluence of the Yellow River and its largest tributary, the Wei. The Wei River has many tributaries on both sides draining a large area of Shensi Province. The Wei River has a tremendous flood potential and contributes very large quantities of silt during floods. At T'ung-kuan the Yellow River turns east, flowing through a gorge area with high loess cliffs on both sides, which contribute large quantities of silt by the undercutting action of the river. About 120 km below T'ung-kuan is the downstream end of the San-men Gorge, and about 140 km below San-men Gorge, at Meng-hsien, the river emerges on the plain area. The dikes, which total about 700 km (north dike) and 570 km (south dike), begin at this point. The flatness of the plain slows the velocity of the river and causes precipitation of silt, so that the river bed between the dikes has been elevated gradually. The surface of the river above the surrounding plain at low water varies from 1.5 meters to 3 meters, and the surface at high water varies from 6 meters to 7.5 meters. In its lower reaches the river meanders between the dikes, with sharp bends in its channel (potential breaching points), and its bed varies in depth. Although the river has a propensity to scour its bed at a certain velocity, both natural and manmade obstructions change the rate of flow and limit the action.**

The Yellow River has four flood periods: the ice flood caused by thawing, especially around Lan-chou and in the area around the mouth; the so-called "peach" flood caused by melting snow; and the summer and winter floods caused by heavy precipitation, the most destructive, with extreme flood flows occurring in August and September. The greatest flood flows come from either the Shansi-Shensi border area or the Wei

* It has been estimated that the area above Pao-t'ou contributes less than 20 percent to the flood and silt flow of the downstream areas.

** It is essential for flood control, irrigation, and navigation in this section of the river that the channel be regulated (straightened) by digging cut-off channels and determing a proper channel width. At the same time, the proper velocity for maintaining silt in suspension or aiding scouring action will be dependent on the rate that water is released from San-men Dam (and other dams controlling the flow into the river below San-men) or is allowed to flow through detention basins.

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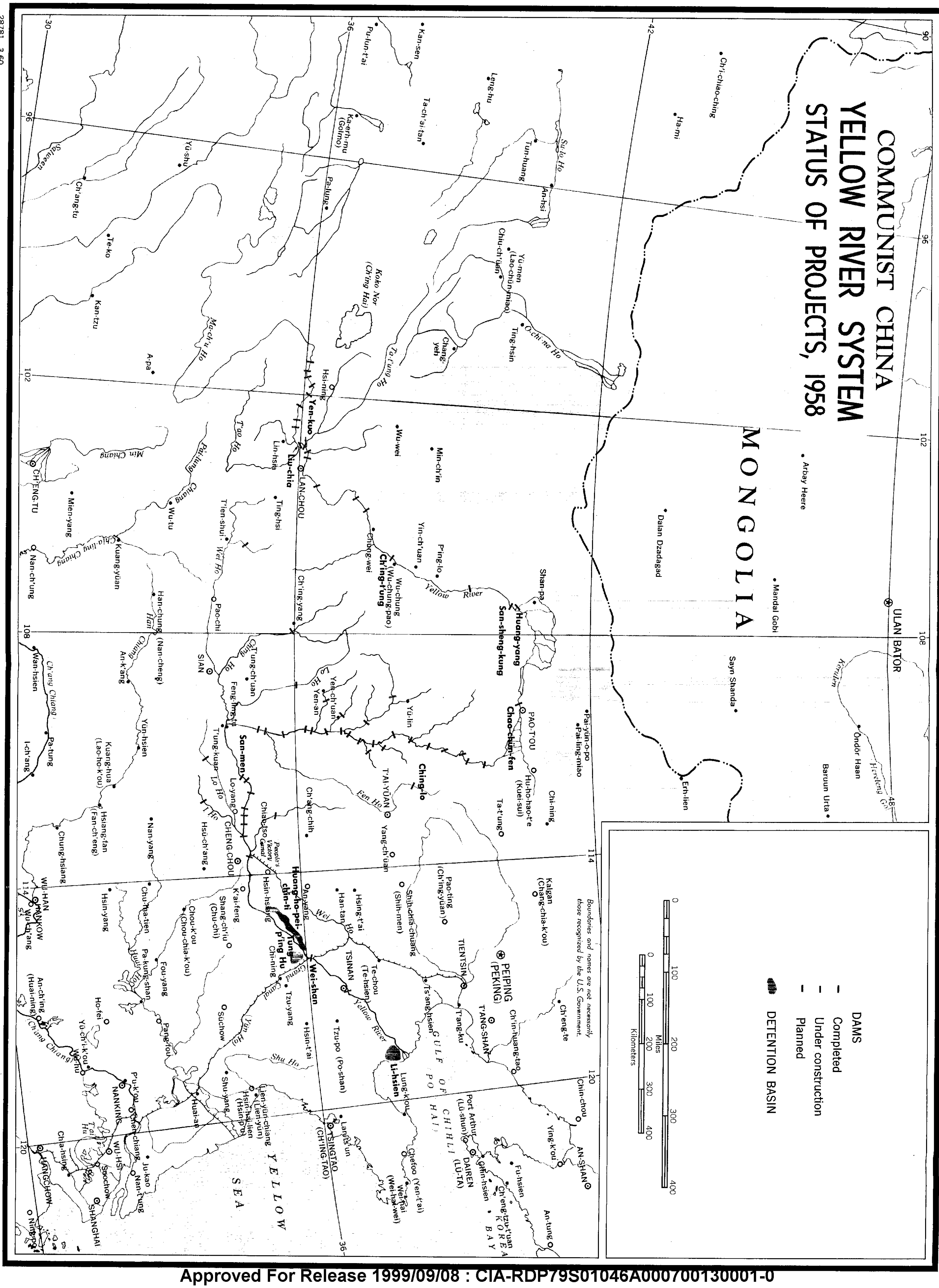

Figure 4

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River system, and because the two drainage areas have numerous tributaries and cover a very large area, they can produce flood hydrographs of entirely different shapes depending on the areal distribution of rainfall. Floods occurring on the Yellow River, therefore, have complicated characteristics, as they can come from a single or a composite source.

Confronted with a problem of controlling such a river with a lack of technical experience and a limited number of engineers, Communist China requested the USSR for aid in 1952, but it was not until January 1954 that Soviet engineers arrived in Peking. In April 1954 the Yellow River Planning Commission was organized, with the Soviet engineers as permanent members, and in the following year the Commission presented the multipurpose plan for approval. The over-all preliminary program called for the construction of 46 dams on the main river; dams on the numerous tributaries, with the primary purpose of retaining silt; and an extensive water and soil conservation program to be carried out in Kansu, Shansi, and Shensi Provinces so as to ensure reduction of silting. Included in the 46 dams was a "staircase plan" for the middle reaches from Ho-k'ou Falls to T'ung-kuan, consisting of a series of about 17 dams; a dam at San-men Gorge, the most important single project for flood control, irrigation, and generation of electric power; two irrigation dams in the lower reaches; and other multipurpose dams, including Liu-chia Gorge, in the upper reaches. It was planned that the dams would ensure flood control and irrigation; that their hydroelectric stations would have a total installed capacity of 23 million kilowatts; and that, when locks were constructed, they would provide navigation from the estuary to Lan-chou for ships of 500 metric tons. 46/

The first phase of the plan, scheduled for completion in 1967, called for the construction of the San-men Gorge and the Liu-chia Gorge projects; silt retaining dams on the Ching, Hu-lu, North Lo, Wu-ting, and Yen-shui Rivers and five other tributaries; and multipurpose dams on the Fen and Pa Rivers. Tributary dams on the I South Lo, and Chin Rivers below San-men Gorge were to be completed by 1964 as a part of the complex. For irrigation purposes, three dams were to be constructed on the main river at Ch'ing-t'ung Gorge, San'sheng'kung (Inner Mongolia), and Tao-hua-yu (Honan), along with main irrigation canals for each project. It was planned that by 1967 silt would be reduced by one-half and that the river would be navigable from the mouth to Tao-hua-yu (703 km), from the Yü-lin River in the Inner Mongolian Autonomous Region to Yin-ch'uan in Kansu Province (843 km), and in the San-men Gorge and Liu-chia Gorge Reservoirs. 47/

The plan of the Commission included some of the features of two earlier plans -- the first by the Japanese in the 1930's and the second by US engineers in the 1940's. Adopted from the US plan was the application of the concept of multipurpose river development to the entire river basin and the general recommendations for carrying out such a program. The "staircase" project and the location of the large dam at San-men were taken from the Japanese plan, which aimed for the greatest possible production of electric power. In appraising the Japanese plans, the US engineers believed that the dams in the "staircase" project would need to be high, or they would become silted rapidly. In addition, the US engineers believed that San-men Gorge should be included in a survey of possible dam sites, but they recommended another site farther downstream. The location of a dam at San-men Gorge would create a storage reservoir that would tend to silt rapidly, and serious problems in engineering would be encountered in devising a method for desilting such a reservoir. Location of a dam farther downstream would create a gully reservoir that would allow for greater river velocity, and the outlets in the dam could be designed more easily to discharge the same amount of silt that entered the reservoir each year. 48/

The US recommendations were based on the belief that an adequate water and soil conservation program to reduce silting in a drainage area as wide as the Yellow River basin would require hundreds of years. Solution of the erosion problem depended on a competent method and organization to carry out the plan, and there was some doubt that complete elimination of silting could ever be realized.

In the years following 1949, hydrological, geophysical, and engineering surveys; soil studies; and water and soil conservation measures were carried out. By 1955 the number of hydrological stations was increased, and a number of hydrologists were trained, but the data accumulated often were inaccurate. A larger hydrological network with trained observers, as well as improved equipment and instruments, was needed. Although a topographical survey was completed on various sections of the river (including San-men Gorge) over an area of nearly 34,000 sq km, only about 15 percent of the area was surveyed with precision instruments. As a result, the quality of topographical surveying did not meet the requirements of the project. Geological surveying and the data obtained were even poorer because of too much emphasis on quantity rather than on quality. An attempt was made to coordinate laboratory technique with field surveys in soil research, but the results were inconclusive because of lack of experience and inadequate equipment. 49/ Thus in spite of the claim that the multipurpose plan in 1955 was based on data compiled since 1949, much additional study was required before construction could be started in 1957 on the first phase of the plan.

Between 1949 and 1955 a substantial amount of flood prevention work was completed in the lower reaches of the river. To perform the work, peasants along the river were organized into construction, reserve, and emergency teams. In all, about 6 percent of the entire length of dikes was reinforced with stone, and the dimensions of the dikes were increased. To protect the dikes, flood detention basins were constructed at Shih-tou-chuang on the north bank, to the west of the Grand Canal, and at Li-ching near the mouth of the river. The construction of numerous, scattered small dikes in local areas was prohibited in order to lessen the chances of silting. Other preventive measures undertaken between 1949 and 1955 included construction of the Peoples Victory Canal, a 52-km trunk canal between the Yellow and Wei Rivers, and the Huang-yang Dam on the Yellow River, in the western section of the arc, to divert flood waters and develop irrigation. 50/

The problem of water and soil conservation was studied, and about 370,000 sq km of the loess area were surveyed. In 1955, at the end of 6 years of work, it was claimed that water and soil loss on an area of about 25,000 sq km was brought under limited control and that the annual amount of silt flow was reduced by about 3 percent. 51/ In 1957, after 2 years of additional work in water and soil conservation, the goal of reducing the silt flow in the Yellow River to one-half of the estimated annual amount (1.4 billion tons) was revised -- only 35 percent of the silting of the Yellow River would be checked within the next 10 years. A longer time would be required to carry out the program because the area (186,000 sq km of Shensi, Shansi, Kansu, and Honan Provinces) was sparsely populated and communications were poor. 52/

Under these precarious conditions, construction was started on the first phase of the Yellow River project in 1957, in particular on the San-men Gorge and the Liu-chia Gorge projects. In 1958, construction was accelerated. The completion date for the San-men Gorge project was again announced as 1961,* which necessitated an earlier completion of projects of the Yi and South Lo Rivers. Accordingly, construction was started on reservoirs on these rivers in 1958, and they were scheduled for completion in 1959, 5 years ahead of schedule. 54/ Two other large projects were started in 1958, the large multipurpose projects at Ch'ing-t'ung Gorge (scheduled for completion in 1960) 55/ and at Yen-kuo Gorge. These two

* Although the original plan of 1955 gave the completion date as 1961, the date had been extended to 1962 during the cutback in construction in 1957. 53/

projects, together with the San-men Gorge and Liu-chia Gorge projects and the Wei-shan irrigation project in the lower reaches, made a total of five large first-phase projects under construction in 1958. 56/

The Chinese Communists are proceeding with this accelerated construction, still faced with a considerable amount of conservation work to be done in relation to the serious silting problem. The reservoirs located in the upper reaches above the arc of the Yellow River will not suffer greatly from this menace. The real difficulty is the San-men Gorge Reservoir, the life of which was originally estimated to be between 50 and 70 years, based on the assumption that silting would be reduced 50 percent by 1967.*

Even if the dam can be designed successfully to let out an estimated 200 million tons of silt per year, 57/ the amount of silt still entering the reservoir would be great enough to silt the reservoir completely in about 50 years.**

* This estimate was made in 1955, based on a silt flow estimate of 1.4 billion tons reduced to 700 million tons. In 1957 it was estimated that the silt flow would be reduced to nearer 900 million tons.
** This estimate is based on the belief that the annual silt flow probably is closer to the older estimate of 1.89 billion tons and that silting cannot be reduced appreciably in the next 10 years.

APPENDIX D

SOURCE REFERENCES

Evaluations, following the classification entry and designated "Eval.," have the following significance:

Source of Information	Information
Doc. - Documentary	1 - Confirmed by other sources
A - Completely reliable	2 - Probably true
B - Usually reliable	3 - Possibly true
C - Fairly reliable	4 - Doubtful
D - Not usually reliable	5 - Probably false
E - Not reliable	6 - Cannot be judged
F - Cannot be judged	

"Documentary" refers to original documents of foreign governments and organizations; copies or translations of such documents by a staff officer; or information extracted from such documents by a staff officer, all of which may carry the field evaluation "Documentary."

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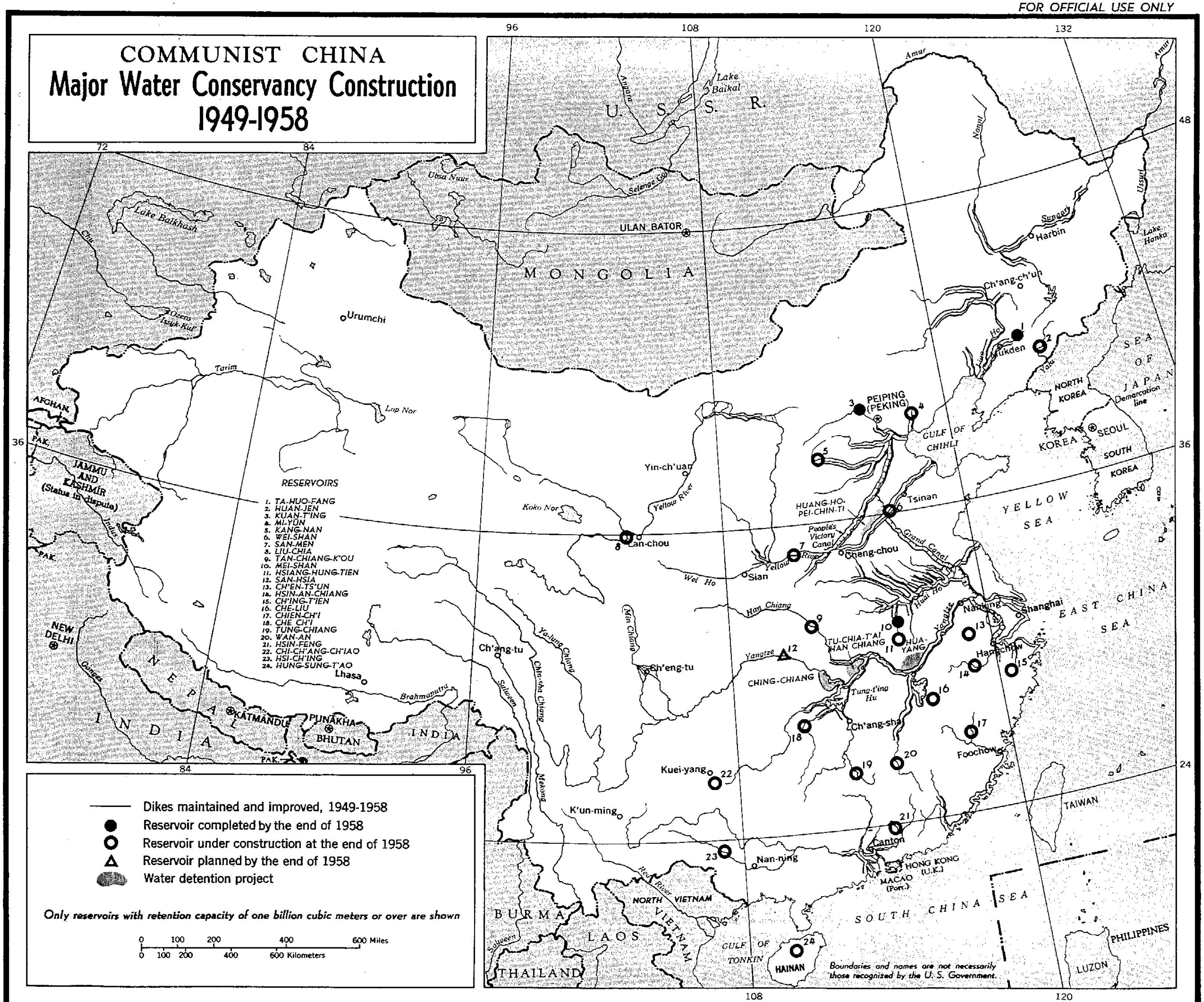

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Figure 2

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